ITSP 2023 Final Documentation

**iKshana**

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**Inspiration for Idea**

| Sticks are usually used by visually-impaired people to navigate, and nowadays smart tech-enabled sticks are also available, but this necessitates carrying around an extra accessory which not only adds to the weight to be carried around, but also easily identifies someone as visually impaired. So, we wanted to build a solution that helps visually impaired people navigate while also making them self-sufficient and increasing their self-confidence and solving both the problems mentioned above, while being affordable and accessible by everyone. |
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**Problem Statement**

| Enabling the visually impaired to safely navigate both indoors and outdoors, and for short-range distances and long-range distances, without making them stand out in public. |
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**Existing solutions in the Market**

| Currently, only one solution exists in the market- Innomake made by the Austrian company Tec-innovation.Innomake are smart shoes, which are made for visually impaired people for better navigation, it is a shoe, with a module attached to it at the front, which gives haptic/audio feedback to the person relaying the information of the obstacle, it is only for short range navigation. It is quite expensive, also does not meet the demand of long range navigation, as well as does not eliminate the need of a walking stick. We have tried to meet these needs, through our vision and prototype. |
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**Proposed Solution**

| We proposed a harness which can be used with any kind of footwear and even barefoot, with a module. There is short range navigation as well as long range navigation. An elastic harness could be worn by people with different foot sizes as well as upon different footwear, hence eliminating the need for a custom pair of shoes. The mechanism would involve object detection and haptic feedback for short range, GPS integration for long range navigation. |
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**Brief Description**

| iKshana consists of modified shoes which can help people with visual impairments navigate through their lives.  It will consist of the following features:   1. Short range navigation coupled with obstacle avoidance using ultrasonic sensors and haptic feedback.   iKshana consists of a wearable lightweight elastic harness, with 2 iKshana modules on the front strap, main one on the front and side one on the outer side. The main module consists of transistors, an ESP32, two 9V batteries, and an ultrasonic sensor. The side module has just an ultrasonic sensor. 2 vibration motors are embedded in the ankle straps of the harness. All the wiring is embedded in the harness.   1. Long range navigation via fetching and processing location data from the user’s phone using an Android app we built, and relaying necessary instructions to the user through haptic feedback, both of the phone as well as the vibrational motors in the harness. We realized a major problem we need to solve which is not already addressed by using Google Maps with voice commands, is navigating intersections and enabling the user to become self-sufficient when it comes to long-range navigation even when he/she does not have a particular destination in mind.   So, we built a database of all intersections at IIT Bombay (which is easily scalable) and integrated this into our app to enable processing of the location data. The app connects to the ESP32s through Wifi using a master-slave configuration. |
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**Progress**

| The work for iKshana had started quite early as soon as the registration process ended. The initial days were us ideating on how we would like to physically realize our vague idea. The objective was clear but there were many technicalities behind bringing the idea to life that we had to tackle. As we ideated, we set a deadline for us to get an initial prototype made with the least faults possible. Before the first review meet, we managed to gather materials and basic hardware that we would use to build our first prototype. We managed to figure out the basic coding and circuitry required too and up until here it was smooth sailing. The real struggle started after we started ideating further and putting the components together, I. E, hardware, software, design and circuitry. Some of the ideas that came up during this period were GPS long range navigation, self powered shoes through piezoelectric transducers and methods to detect more detailed environment variables such as stairs or ditches. Of course, we couldn't induct all these ideas into our model before the presentation (though we plan to still continue working on iKshana :)) but we still managed to model a template for long range navigation, in spite of it still being quite inaccurate. It was something we could build on. But yes, these ideas brought about the challenges we faced. Be it writing a sophisticated code to build an App or pondering and testing on how to ensure that our power source is reasonably practical. We presented our ideas and a basic prototype in the second review meeting after which we basically worked on implementation of everything we had thought of, optimization and testing the prototypes. It was a lot of labor until the final presentation rolled around. A lot of mechanical and soldering problems but then there's a limit to professionalism at this scale. The final presentation, I'd say, went decently well. We were able to convey our idea and had a base setup for upscaling our 'product'. The work distribution within the team was fairly visible, in spite of all of us being somewhat involved in all four pillars of technology, each one of us took care of most of the work related to one pillar. Abhineet took charge of the software, Chinmay handled the electronics and circuitry, ash on the other hand worked on the mechanical aspects of the harness while Tanish gave inputs on the design and ergonomics. Overall ITSP was a fun journey right from the start to end and we hope to build on whatever we have worked on in the past three months. |
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**Results**

| We were successfully able to implement our Hardware design → an elastic harness for shoes with the circuitry (wires and vibration motors) enveloped in the layers of the fabric (elastic material derived from exercise bands and other clothing straps), in such a way that it provided comfort and flexibility for the user. These included 2 3D-printed containers each, one for the ESP-32, power source (battery 9V) and ultrasonic sensor, and the other solely for the ultrasonic sensor, both attached to the front strap of the harness. The positioning of the motors is done keeping the sensitive spots of the foot in mind. The containers are made taking into account the slope of the foot, to avoid the tip of the shoe from interfering with the sensor readings.  **Images of working prototype:** [**https://drive.google.com/drive/folders/1Ig2sniTf5P7O6wktQ2BC-9je7Q4N-RaD?usp=drive\_link**](https://drive.google.com/drive/folders/1Ig2sniTf5P7O6wktQ2BC-9je7Q4N-RaD?usp=drive_link)  The circuitry involved consists of 2 vibration motors, 2 ultrasonic sensors, and 1 ESP-32 with Wi-Fi module on each foot. We made schematics for a PCB, but didn’t go through with the plan.  **Schematics and Circuit design:**  [**https://drive.google.com/drive/folders/1sSLOdKKDMWRoFTWcWiBK0gRDPTWaALst?usp=drive\_link**](https://drive.google.com/drive/folders/1sSLOdKKDMWRoFTWcWiBK0gRDPTWaALst?usp=drive_link)  Both of these harnesses support navigation through obstacle detection, and intersection maneuvering, through haptic feedback controlled by an app we have made, along with the normal ultrasonic sensor signals for obstacle detection.  **Calibration and Testing Video link:**  [**https://drive.google.com/drive/folders/17X17TYm32IvDvioyiPIxiAOjo6zIONdQ?usp=drive\_link**](https://drive.google.com/drive/folders/17X17TYm32IvDvioyiPIxiAOjo6zIONdQ?usp=drive_link)  The Android app ‘Ikku’ obtains the user’s location through an API, and holds data about road intersections such as their coordinates, obtained by parsing data taken from OpenStreetMap using the Osmium library in python (has geocoding functions). Using this information, on approaching an intersection, relevant data is sent to the ESP-32 with Wi-fi modules, which then creates specific types of vibrations to help the user navigate such junctions.  **Github Repository we made for the app relevant code:**  [**https://github.com/Cove1/iKshana**](https://github.com/Cove1/iKshana)  We put together a presentation for the exhibition as well, complete with one iKshana on display and one for demonstration.  **Final Presentation Link:**  [**https://www.canva.com/design/DAFrTdFKV9U/2iEGYVl7y515jj0FvZN8CA/edit?utm\_content=DAFrTdFKV9U&utm\_campaign=designshare&utm\_medium=link2&utm\_source=sharebutton**](https://www.canva.com/design/DAFrTdFKV9U/2iEGYVl7y515jj0FvZN8CA/edit?utm_content=DAFrTdFKV9U&utm_campaign=designshare&utm_medium=link2&utm_source=sharebutton)  **Final Demonstration Link:**  [**https://drive.google.com/drive/folders/1-f88d2Taql5noqG\_k69yPLzxBKqfX2uR?usp=drive\_link**](https://drive.google.com/drive/folders/1-f88d2Taql5noqG_k69yPLzxBKqfX2uR?usp=drive_link) |
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**Learning Value**

| We learned the following technical skills- Photoshop and Illustrator (Modelling), Fusion 360 (Modelling).  Android Studio, Fused Location Provider (FLP) client, Open Street Map (OSM), Osmium library, for app development and navigation.  Circuitry, soldering, power management, a bit of microcontroller and analog theory, reading datasheets, for main circuitry and integration.  PCB Design. We propose to fabricate PCBs for our product as we move ahead.  Stitching, Mechanical Design, ergonomics, optimisation, in designing the harness and the final integration.  Entrepreneurial skills, in presentation.  Team work, work distribution, time management, street smartness, throughout the project. |
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**Software/ Hardware used**

| Hardware:  Elastic straps, Exercise wrist bands, stitching equipment, adhesives. (for the harness) ESP32 microcontroller, BJT transistors, HC-SR04 ultrasonic sensors, C1026B002F coin vibration motors, 9V batteries, resistors, jumper wires, single strand wires (Electrical)  Softwares: Arduino IDE, Fusion 360, Photoshop, Adobe Illustrator, Fused Location Provider (FLP) client, Open Street Map (OSM), Osmium Library, Jupyter Notebooks, Android Studio. |
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**Suggestions for others**

| Short range navigation:   * Work towards using better sensors, which will have a better field of vision as well as an increased accuracy. * Think of how to solve the problem of detecting objects above the foot level, and how to detect steps and ditches. * Working towards LiDAR sensors, image processing would be the best. * Think of better and lighter, and more durable power sources. * Fabricating a PCB would reduce a lot of weight as well as volume. * Incorporate more vibration motors, in distinguishable locations, for better information relaying. * Work towards making the vibration frequency as well as amplitude controllable.   Long range navigation:   * Work towards getting more refined and accurate location data, detecting distances as small as possible. * Implement ML algorithms to learn the paths a user usually takes, thus improving on safety and reliability. |
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**Contribution by each Team Member**

| * Yash Bhake has worked on the mechanical design and its fabrication, as well as helped with the electronics assembly, debugging the assembly. * Abhineet Agarwal has worked on the software part, app development, api integration, navigation analysis, and integration with the ESPs. * Chinmay Moorjani has worked on the electronics, the CAD design, the ESP code, debugging circuitry, assembly * Tanish Raghute has worked on the Illustrator designs, navigation analysis, presentations and pitching.   Besides, everyone has been involved in ideation. |
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**References and Citations**

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